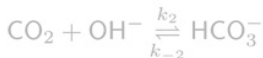


Mathematics for Science and Industry

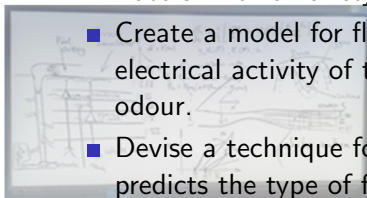
Undergraduate thesis topics

C. Sean Bohun



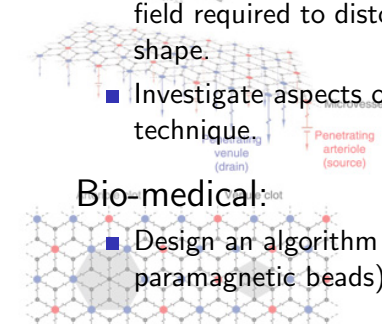
Environment & Sustainability:

- Develop a simulation for the chemical behaviour of 'natural waters' with a variety of ionic contaminants.
- Create a model for fly locomotion based on a record of electrical activity of the insects antenna in the presence of an odour.
- Devise a technique for power transmission line arrays that predicts the type of fault and the fault location.



$$M[A] = A \left[\frac{1}{2} - \frac{\nu}{2} \cos \left(\mu \pi e^{-T^2} \right) \right], \quad F[A] = A e^{ib|A|^2}, \quad L[A] = Ah.$$

C. Sean Bohun



Bio-medical:

- Design an algorithm to collectively move cells (embedded with paramagnetic beads) to form a biological scaffold.

[illegible]

Jane Breen (on leave)

$$\frac{n-1}{2} \leq K(P) \leq \frac{n-1}{1-\lambda_2}$$

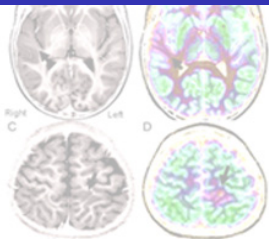
$$\bar{E}(h) = \sum_{j=1}^n m(F_j) \max_{x \in F_j} h(x)$$



Possible topics:

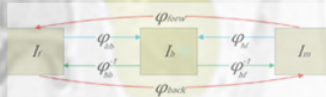
- Clustering algorithms in directed networks (with application to road traffic dynamics).
- Kemeny's constant and graph connectivity.
- Sensitivity analysis of Markov chain models.

$$-1 \leq \lambda_n \leq \lambda_{n-1} \leq \cdots \leq \lambda_2 < \lambda = 1$$



Medical imaging:

- Medical image registration.
- Medical image segmentation.
- Medical image fusion.



Greg Lewis



$$\nabla \cdot \mathbf{E} = \frac{1}{\epsilon} \rho,$$

$$\nabla \cdot \mathbf{B} = 0,$$

$$\nabla \times \mathbf{E} = -i\omega \mathbf{B},$$

$$\nabla \times \mathbf{B} = \mu ((\sigma + i\omega\epsilon) \mathbf{E} + \mathbf{j}_s)$$



Possible topics:

$$\frac{\partial \mathbf{u}}{\partial t} = \mu \nabla^2 \mathbf{u} + \nabla \times (\Omega \times \mathbf{u}) + \nabla (T - T_r) - \frac{1}{\rho_0} \nabla p - (\mathbf{u} \cdot \nabla) \mathbf{u},$$

$$\frac{\partial T}{\partial t} = \kappa \nabla^2 T - (\mathbf{u} \cdot \nabla) T,$$

■ Transitions in atmospheric flow patterns.
■ Mathematical models for electro-location in weakly electric fish.

$$\nabla \cdot \mathbf{u} = 0$$

■ Mathematical aspects of MRI.



Possible topics:

- Phase transition in interface formation. Will include elements of: theory of interface formation, stochastic partial differential equations, numerical methods, data analysis.
- Bifurcations in a strained food chain model. Will include elements of: population dynamics, numerical bifurcation analysis, normal form analysis.
- Stability analysis of shear flows. Will include elements of: Navier-Stokes flow, energy methods, Squire's theorem, Orr-Sommerfeld equations.

